The Virial in Thermodynamics

In my letter on the Virial in NATURE, vol. xviii. p. 39, a line of the description of a force's "radiancy" (as it was there termed) with respect to a given point was accidentally omitted; and the definition should have been the product of the distance of its point of application from the given point or "focus," and the resolved part of the force in the direction of that distance, the last and most important member of which product was unmentioned by some unintentional oversight in the description. It would also be wrong, in the dynamical equation of the virial, the *vis viva* and the radiancy of momentum of a system to range the *vis viva* and virial together (as I did in the letter) in the class of physical agents, bound therefore by known laws of conservation, since either their joint or their separate effects in changing the system's total radiancy of momentum are easily seen, if we suppose one of them, for example, the *vis viva*, to act alone, to be totally unfettered, and therefore their actions to be of a measurable kind, but not subject, like that of natural agents, to any known laws of physical connection.

The rate of acceleration of a fourth part[1] of the triple sum formed of a system's moments of inertia round any three axes at right angles to each other is the rate of change of its total radiancy of momentum, and if the various parts of the system are all moving uniformly in straight lines, their joint *vis viva* measures the rate of this change; but it cannot be said to cause or produce it, since, by the laws of motion, the bodies *unassisted* or left to themselves will continue to produce, by their *vis viva*, the same rate of change, without connection in doing so, with any known physical agent, from whose class, accordingly, it is evident that both *vis viva* and the "virial," or the radiances of a system's forces as linked in an equation with acceleration of total moment of inertia, are formally excluded. The equation has very important applications: as when, on an average of a sensible time, the total moment of inertia remains unaltered, or when a system is apparently at rest: for example, in the case of immobility of a gravitating atmosphere in a state of equilibrium, under any possible assigned law of variation of temperature. But the idea of this state of immobility being a necessary one, which the *vis viva* and virial together of the ponderable mass is constrained to conserve—placing them together in a fixed and definite relationship to each other, or to any other agents of physical phenomena, subject to known laws of conservation—was evidently a totally mistaken and unreal one.

A. S. HERSCHEL

[1] The acceleration of the total moment instead of the fourth part of the total moment of inertia was wrongly written in the postscript of my letter as equal to the rate of change of momentum-radiancy. Actual energy and "virial," as defined by Clausius, are also half of the quantities here described as *vis viva*, and radiancy of a force.

The Meteor of May 12

In NATURE (vol. xviii. p. 105) the statement occurs among the "Notes" that the brilliant bolide of May 12 was seen at Geneva, the local time being said to agree. May I call your attention to the fact that the difference between Greenwich and Geneva is 25 minutes (or 2 minutes more if Berne time is compared). Thus 9.45 is 9.20 Greenwich time, nearly half an hour after the meteor recorded by English observers. It is now a well recognised fact that large meteors come in *groups*, naturally raising the suggestion that such groups form part of a slowly disintegrating mass.

From records I have obtained from Scarborough, Leeds, and Bradford, combined with an excellent observation of the latter part here, and the notices contained in your number for May 16, I find the *probable* positions of beginning and end to be from 4 miles west of Northallerton to 5 miles west of Hawick, a distance of 94 miles, the angle of flight being 38° with the horizon, making an actual course of 108 miles described in about 9 seconds, giving the unusually slow rate of 12 miles per second. This, and one or two other points, make it possible that the course really extended further. But the end was in nearly all instances obscured by clouds and the observations in line with the meteor's course. An exact description of its course by your Edinburgh correspondent (especially as to whether it passed near the zenith) would make this certain.

May I venture to make one or two suggestions to your correspondents who favour you with notes on meteors? When, for any reason, celestial measurements cannot be given, *rough measurements* of the positions made either by holding a ruler in front of you, or, if light allows, by the minutes upon a watch face, which shall enable the actual height, and distances from a point of the compass to be determined, are by far the most valuable items, accompanied of course by exact time, date, and place. Thus a meteor might appear at a height of 15 inches on a base 27″ (an arm's length) and 12″ W. of north. Or, having placed 12 o'clock level, the hand at 10 minutes past might point to the place of disappearance, an angle of 7 minutes (42°) giving the distance E. of south. Prof. Herschel, of Newcastle, gives some capital hints in a letter published in the *Scotsman*, May 1, upon the March daylight meteor. Either he or Capt. G. L. Tupman (or I myself) would at any time be glad of observations, in which case a rough plan, indicating its position among the stars, would be of great value. The position of the meteor with reference to houses, trees, &c., the course across a window, if seen indoors (the observer's position and distance being also given and the points of the compass), and many similar items are very useful for after reference and may lead to very exact determinations.

J. EDMUND CLARK

20, Bootham, York, May 28

"Divide et Impera"

VERILY we have divided and subdivided, and as yet are but little nearer the "command" promised.

I am a subscriber to your able magazine, which is extensively read in South America, and beg to bring the following subject to the notice of your zoological readers:—

At this distance of 8,000 miles and at the outskirts of civilisation, books of reference are scarce, or, if existing, difficult of access. In constructing some zoological tables I am constantly beset by the difficulty of discovering two, three, four, five, six, or more synonyms for the same species, or in the case of a supposed new species find afterwards that the same animal has been described under another name; the genera often differ! the families constantly vary, and even the higher classification is by no means constant.

Where is all this perpetual confusion to end? In the science being destroyed by excessive or faulty nomenclature? We want an Ariadne with her thread to lead us out of the maze, for such it is, especially to young zoologists like myself.

Is it too much to expect that an international zoological congress should be constituted with power to methodise and reduce to order this chaotic classification, and print and publish authorised lists of fauna? How are young naturalists to progress, constantly hindered as they are by wasting weary hours in seeking for that which should be patent at a glance?

Such a congress should, by unanimous consent of the chief zoological societies of Europe, fix immutably not only the superior classification, but also the generic and specific nomenclature; and in the event of new species being discovered, whilst conceding the right to the discoverer and describer to affix its title, this should in all cases be subject to the approval of the International Congress, which might sit permanently in the shape of one or two deputies.

It seems to me the science has already emerged from its swaddling clothes, and it is high time for our scientific authorities to give up that fatal habit of generating and clinging to their own superstitions, and fostering that intense jealousy so characteristic of them, which, leading to multiplicity of systems, leads only to distraction.

There may be aberrant forms yet undecided (there will be such, perhaps, to the end of time); borderlands to be limited; yet there is ample material to fix unalterably and universally the skeleton of that science, to fill in whose details there are multitudes of willing and skilled hands, ready to aid, in all parts of the world.

E. W. WHITE

Buenos Ayres, May 1

A Quadruple Rainbow

In the afternoon of Friday, the 24th ult., while proceeding by rail to Dublin, and before reaching Abbeyleix station, I observed the curious phenomenon of four rainbows forming a single bow—that is, without any dark space intervening between the colours. The four bows were all of the same, or nearly the same, breadth, but I cannot say whether all the colours were present in each.

The brighter colours—as the red and yellow—showed that the bows were arranged in the same order.

I called the attention of several other passengers to the novel spectacle.

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A word in explanation of this strange appearance from some of your learned contributors would, I think, be interesting.

Model School, Waterford, June 1 HENRY P. DOWLING

Classes for Women at University College

IN view of the new charter enabling the University of London to confer degrees on women, and the increased demand for a higher education of women, the council of this college have determined to provide for them systematic instruction in regular college classes.

In most subjects the junior classes for women will be distinct from those attended by male students. The senior classes will more generally be open to both sexes, and these classes, which are already open to both, as fine arts, philosophy of mind, &c., will remain so.

Prospectuses embodying the results of this change will be ready by the 18th inst. TALFOURD ELY

University College, London

[OUR St. Petersburg correspondent, "C. S." must send us his name (in confidence), before we can publish his last communication.]

PROF. JOSEPH HENRY, LL.D.

PROF. HENRY was born December 17, 1797, at Albany, New York, where also much of his early life was passed. The year of his birth seems, however, uncertain, some authorities placing it in 1799, or even later. He had at first the advantages of only a common school education. A parish library supplied him with boyish reading, and his early tastes were in the direction of romance and the drama. He was nearly grown when the accidental possession of a copy of Robinson's "Mechanical Philosophy" turned his thoughts towards natural philosophy. After two years of work as a watchmaker, he came under the training of the Albany Academy, where he developed a degree of mathematical talent which, in 1826, led to his selection for the duties of instructor in mathematics in that institution. Prior to this, having had some experience in the field as a surveyor, he was associated with Amos Eaton in the Geological Survey along the line of the Erie Canal, projected and sustained by General Stephen van Rensselaer. Failing physical health led to his taking this step. He returned home with a robust constitution, which never failed him throughout his life.

While occupied with his duties as mathematical instructor in the academy—then in charge of Dr. T. Romeyn Beck—he commenced that line of investigation in electricity which resulted in the important discoveries that have made his name famous. He attended the lectures on chemistry of Dr. Beck, and assisted in the preparation of his experiments. At this time he devised and published an improved form of Wollaston's sliding-scale of chemical equivalents, in which hydrogen was adopted as the radix—a contrivance which is hardly known, even by name, to the present generation of chemists. Thus, while Prof. Henry's original contributions to science were chiefly physical, his first scientific work was in the department of chemistry. His work with Dr. Beck enabled him, after his removal to Princeton—where he became professor of natural philosophy in 1832,—to take up the duties of the chemist, Dr. John Torrey, when that well-known teacher was disabled for a time by ill health.

It was in the interval between 1828 and 1837 that the most important work of his life was accomplished in the line of strictly scientific research.

If we compare the poverty of his apparatus and the poverty of his means for research and publication with the importance of the results which he reached, we may accord him a place by the side of Faraday as an experimentalist. He became the sole discoverer of one of the most singular forms of electrical induction, and was among the first, perhaps the very first, to see clearly the laws which connect the transmission of electricity with the power of the battery employed. One of the problems to which he devoted himself was that of producing mechanical effects at a great distance by the aid of an electro-magnet and a conducting wire. The horse-shoe electro-magnet, formed by winding copper wire round a bar of iron bent into the form of a U, had been known before his time, and it was also known that by increasing the number of coils of wire greater force could be given to the magnet, if the latter were near the battery. But when it was removed to a distance the power was found to weaken at so rapid a rate that the idea of using the electro-magnet for telegraphic purposes seemed hopeless. Henry's experiments were directed toward determining the laws of electro-motive force from which this diminution of power resulted, and led to the discovery of a relation between the number of coils of wire round the electro-magnet and the construction of the battery to work it. He showed that the very same amount of acid and zinc arranged in one way would produce entirely different effects when arranged in another, and that by increasing the number of cells in the battery there was no limit to the distance at which its effects might be felt. It only remained for some one to invent an instrument by which these effects should be made to register in an intelligible manner, to complete the electro-magnetic telegraph, and this was done by Morse. Henry himself considered the work of an inventor as wholly distinct from that of a scientific investigator, and would not protect the application of his discoveries, nor even engage in the work of maturing such applications. He never sought to detract from Morse's merits as the inventor of the magneto-electric telegraph, but did on one occasion, under legal process, give a history of the subject which was not favourable to Morse's claim to the exclusive use of the electro-magnet for telegraphic purposes. Some feeling was thus excited; but Henry took no other part in the controversy than to ask an investigation of some charges against himself contained in an article of Morse's.

The results of these researches are chiefly recorded in the *Transactions* of the Albany Institute, the volumes of the *American Journal of Science and Arts* for the period, and the *Transactions* of the American Philosophical Society. His "Contributions to Electricity and Magnetism" were collected in a separate volume in 1839. The analysis of these important researches, and the discussion of the questions of priority connected with them, will be the duty of the academician to whom shall be assigned the preparation of a memoir or eulogy of the distinguished author.

The memoir in the *American Journal* gives a list of twenty-two memoirs and discoveries by Prof. Henry. To these papers should be added an important series of communications, made chiefly to the National Academy of Sciences during the past four or five years, upon the laws of acoustics as developed in the course of investigations conducted for the Light-House Service in order to determine the various conditions involved in the transmission of fog-signals. These investigations have been carried forward mainly in government vessels, and occupied Prof. Henry's close personal attention during many weeks of each season.

Besides these experimental additions to physical science, Prof. Henry is the author of thirty reports, between the years 1846 and 1876, giving an exposition of the annual operations of the Smithsonian Institution. He has also published a series of essays on meteorology in the Patent Office Reports, which, along with an exposition of established principles, contain many new suggestions, and, among others, the origin of the development of electricity, as exhibited in the thunderstorm.

In 1837 he visited Europe and made the acquaintance

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